Biological Opinion

Bonnet Carré Spillway 2011 and 2016 Emergency Operations

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CONSULTATION HISTORY

2011 Emergency Operation

April 27, 2011 – U.S. Army Corps of Engineers, New Orleans District (USACE) contacted the U.S. Fish and Wildlife Service's (Service) Louisiana Ecological Services Office, via telephone, to discuss the implications of a near-term, future 2011 Bonnet Carré Spillway (BCS) opening on the federally endangered pallid sturgeon and recently listed shovelnose sturgeon, which was federally listed under the Similarity-of-Appearance Provisions of the ESA in 2010 (Service 2010). During this conversation the USACE expressed its continued commitment to conducting retrieval efforts for pallid and shovelnose sturgeon entrained through the BCS. The USACE tasked the U.S. Army Engineer Research and Development Center (ERDC) with preparing a scope of work (SOW) for their retrieval efforts, and to determine specific actions that would reduce or eliminate incidental take during future operations of the spillway. The following five tasks were identified for this study:

Task 1: Recover pallid sturgeon entrained through the BCS.

Task 2: Evaluate movement of sturgeon in the floodway and into Lake Pontchartrain using sonic telemetry.

Task 3: Assess fish community composition.

Task 4: Determine salinity tolerance of shovelnose sturgeon.

Task 5: Prepare report.

May 5, 2011 – The USACE sent a letter to the Service requesting the initiation of emergency consultation for potential impacts to pallid and shovelnose sturgeon. Enclosed within this letter was a copy of the SOW for ERDC efforts.

May 6, 2011 –The Service provided a written response to the USACE containing four conservation recommendations for the operation of the BCS. The conservation recommendations were based on an expansion of the tasks identified during the April 27, 2011, telephone conversation. The conservation recommendations provided by the Service were as follows:

Task 1: Recover pallid sturgeon entrained through the BCS and return them to the river.

Task 2: Tag and track (either actively and/or passively) shovelnose sturgeon (as a surrogate species for the pallid sturgeon) with sonic transmitters to determine movement within and out of the spillway and, if possible, relate those movements to environmental conditions.

Task 3: Determine salinity tolerance of shovelnose as a means of possibly determining dispersal of pallid sturgeon during spillway operation.

Task 4: Provide a report documenting completion of the above recommendations.

May 27, 2011 – The Service provided their comments on the ERDC SOW provided on May 6, 2011.

2016 Emergency Operation

December 30, 2015 – The USACE requested initiation of emergency consultation with the Service via telephone regarding the potential for entrainment of pallid and shovelnose sturgeon through the BCS.

January 5, 2016 – The USACE initiated, via letter dated January 4, 2016, emergency consultation for the endangered pallid sturgeon and the threatened shovelnose sturgeon.

January 6, 2016 – The Service responded to the USACE, providing seven conservation recommendations for the sturgeon that the USACE could undertake to minimize the potential for take of the species during the structure's operation.

Task 1: Prior to the scheduled opening, deploy continuous-recording discharge meters within the spillway to evaluate parameters such as discharge versus pallid sturgeon catch rates. Locations of these meters should be coordinated with the ERDC and the Service.

Task 2: Recover pallid sturgeon entrained through the BCS and return them to the river. Prior to their return, individuals should be tagged and appropriate data collected.

Task 3: Tag and track shovelnose sturgeon (as a surrogate species for the pallid sturgeon) with sonic transmitters to determine movement within and out of the spillway and, if possible, relate those movements to environmental conditions.

Task 4: Determine salinity tolerance of shovelnose as a means of possibly determining dispersal of pallid sturgeon during spillway operation.

Task 5: To the maximum extent practicable conduct a slow closure of the BCS once the flood threat is eliminated.

Task 6: Reexamine pallid sturgeon demographics and update the 2013 population viability analysis to determine if the spillway opening impacts the long-term viability of that species.

Task 7: Provide a report documenting completion of the above recommendations.

March 20, 2017 – The USACE provided a Draft Biological Assessment (BA) for BCS 2011 and 2016 Emergency Operation to the Service for review and comments.

April 12, 2017 – The Service responded to the USACE with comments on the Draft BA.

December 19, 2017 – The USACE initiated, via letter dated December 12, 2017, formal consultation with the Service on the BCS 2011 and 2016 Emergency Operations. Enclosed within the letter was a Final BA for the Emergency Operations.

January 12, 2018 – The Service responded via letter to the USACE providing confirmation that all information had been received and that our biological opinion for both would be issued no later than May 3, 2018.

April 20, 2018 – The Service requested via electronic mail a 45-day extension for issuance of the final BO. The extension was granted by the USACE on April 20, 2018.

In their December 12, 2017, request for consultation and final BA, the USACE determined that their actions had no effect on the Atlantic sturgeon (Gulf subspecies) or its critical habitat, the West Indian manatee, the piping plover, the red knot, and the Kemp's ridley, green, loggerhead, hawksbill and leatherback sea turtles. The Service agrees that the actions had no impacts to these species.

Table 1. Species and critical habitat evaluated for effects and those where the Service has concurred with a no effect determination.

Species	**Present in Action Area**	**Present in Action Area but "No Effect"**
West Indian manatee	Possible	Yes
Atlantic sturgeon (Gulf Subspecies)	Possible	Yes
Green sea turtle	Not present	No
Hawksbill sea turtle	Not present	No
Kemp's Ridley sea turtle	Not present	No
Leatherback sea turtle	Not present	No
Loggerhead sea turtle	Not present	No
Piping plover	Possible	Yes
Red knot	Possible	Yes

BIOLOGICAL OPINION

1. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under section 7 (§7) of the Endangered Species Act of 1973, as amended (ESA), as to whether a Federal action is likely to jeopardize the continued existence of species listed as endangered or threatened, or result in the destruction or adverse modification of designated critical habitat. The Federal actions addressed in this BO are the U.S. Army Corps of Engineers, New Orleans District (USACE) Bonnet Carré Spillway 2011 and 2016 Emergency Operations.

Consultation was requested by the USACE on the effects of the actions to the endangered pallid sturgeon (PS; *Scaphirhynchus albus*) and threatened shovelnose sturgeon (SS; *Scaphirhynchus platorynchus*). The SS was listed under the ESA as a threatened species, due to its similarity of appearance to PS. When a species is considered threatened under the ESA, the Secretary may specify regulations, commonly referred to as ‘‘special rules,’’ that he deems necessary to provide for the conservation of that species. The special rule for SS prohibits take of any SS, shovelnose-pallid sturgeon hybrids, or their roe when associated with or related to a commercial fishing activity in those portions of its range that commonly overlap with the range of the endangered PS. All otherwise legal activities involving SS and shovelnose-pallid sturgeon hybrids that are conducted in accordance with applicable State, Federal, tribal, and local laws and regulations are not considered to be take under this regulation. This designation of similarity of appearance under §4(e) of the ESA also does not extend any other protections of the ESA, such as the consultation requirements for Federal agencies under §7, to SS. Therefore, Federal agencies are not required to consult with us on activities they authorize, fund, or carry out that may affect SS.

This BO considers the effects of the actions on PS. There is no designated critical habitat for this species; therefore, none will be affected.

A BO evaluates the effects of a Federal action along with those resulting from interrelated and interdependent actions, and from non-Federal actions unrelated to the action (cumulative effects), relative to the status of listed species and the status of designated critical habitat. A Service opinion that concludes a proposed Federal action is *not* likely to jeopardize species and is *not* likely to destroy or adversely modify critical habitat fulfills the Federal agency’s responsibilities under §7(a)(2) of the ESA. In this BO, only the jeopardy definition is relevant, because the actions do not affect designated critical habitat. “*Jeopardize the continued existence*” means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). The basis of our opinion for the PS and SS is developed by considering the status of the species, its environmental baseline, the effects of the action, and cumulative effects.

This BO uses hierarchical numeric section headings. Primary (level-1) sections are labeled sequentially with a single digit (e.g., 2. PROPOSED ACTION). Secondary (level-2) sections within each primary section are labeled with two digits (e.g., 2.1. Action Area), and so on for level-3 sections.

2. PROPOSED ACTIONS

2011 Emergency Operations

Heavy rains and snowmelt, during April 2011 in the Mississippi and Ohio River valleys, prompted the USACE to initiate flood control activities along the lower Mississippi River. In late April 2011, stage predictions for the Mississippi River indicated that the flow of water in the river below the Bonnet Carré Spillway (BCS) would exceed 1,250,000 cubic feet per second (cfs). As a result, the Commander of the USACE Mississippi Valley Division and President of the Mississippi River Commission, Major General Michael J. Walsh, ordered the BCS to be partially opened on May 9, 2011, to prevent the loss of life and property from floodwaters on the Lower Mississippi River.

The BCS was partially opened on May 9, 2011, and remained partially opened until June 20, 2011. During the 43-day period, adjustments were made to the volume of water flowing through the structure and into the adjacent, brackish, Lake Pontchartrain by removing and then reinserting the wooden pins to control the diversion of water. Pins are removed and replaced incrementally in equal numbers from opposite sides of the structure per the sequence of operation. Two cranes, which move along tracks atop the structure, are used to individually lift each pin from the required number of bays. The pins are raised from their vertical position across the weir opening and are laid horizontally on top of the structure for later use in its closing. Within seven days, the USACE opened 330 of the 350 total bays. Once the 330 bays were opened the discharge through the BCS increased to a maximum of approximately 315,930 cfs. The 330 bays stayed open for 27 days. The USACE began the closing sequence of the BCS on June 11, 2011. On the 43rd day of operation, 10 days after the initiation of closure operations began, the falling Mississippi River caused the BCS to become hydrologically disconnected. During operation of the BCS, flows passing through the structure averaged about 207,909 cfs.

2016 Emergency Operations

Heavy rains, during late December 2015 in the Mississippi and Ohio River valleys, prompted the USACE to initiate flood control activities along the lower Mississippi River. In late December 2015, stage predictions for the Mississippi River indicated that the flow of water in the river below the BCS would exceed 1,250,000 cfs. As a result, the Commander of the USACE Mississippi Valley Division, Major General Michael C. Wehr, ordered the BCS to be partially opened on January 10, 2016, to prevent the loss of life and property from floodwaters on the Lower Mississippi River.

The BCS was partially opened on January 10, 2016, and remained partially opened until February 1, 2016. During the 22-day period, adjustments were made to the volume of water flowing through the structure and into the adjacent, brackish, Lake Pontchartrain by removing and then reinserting the wooden pins to control the diversion of water. Within eight days, the USACE opened 210 of the 350 total bays. Once the 210 bays were opened, the discharge through the BCS increased to a maximum of approximately 202,500 cfs. The 210 bays stayed open for eight days. The USACE began the closing sequence of the BCS on January 25, 2016. On the 22nd day of operation, the falling Mississippi River caused the BCS to become hydrologically disconnected.

2.1. Action Area

For purposes of consultation under ESA §7, the action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). The "Action Area" for this consultation includes the Bonnet Carré Spillway, St. Charles Parish, Louisiana (Figures 1 & 2).

2.2. Interrelated and Interdependent Actions

A BO evaluates the effects of a proposed Federal action. For purposes of consultation under ESA §7, the effects of a Federal action on listed species or critical habitat include the direct and indirect effects of the action, plus the effects of interrelated or interdependent actions. "Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR §402.02).

The Service defines the action area as that area including all direct and indirect effects of the action. PS have been observed to exhibit seasonal variation in movement patterns based on temperature and discharge and are capable of moving long distances in search of favorable habitat. Given the limited duration of this action, it is probable that the most significant direct and indirect effects of these actions occurred within the Mississippi River in the Coastal Plain Management Unit (as defined in the recovery plan).

In their request for consultation, the USACE did not describe, and the Service is not aware of, any interrelated or interdependent actions to the actions. Therefore, this BO does not further address the topic of interrelated or interdependent actions.

2.3. Figures for Proposed Actions

Figure 1. Location map of the BCS on the Mississippi River and drainage into Lake Pontchartrain. (USACE 2017)

Figure 2. Detailed view of the BCS and water body names in the BCS (USACE 2017).

3. STATUS OF SPECIES

This section summarizes best available data about the biology and current condition of PS throughout its range that are relevant to formulating an opinion about the actions. The Service published its decision to list the PS as endangered on October 9, 1990 (55 FR 36641-36647). The reasons for listing were habitat modification, apparent lack of natural reproduction, commercial harvest, and hybridization in parts of its range. Critical habitat has not been proposed or designated for the PS. The Service conducted a 5-year review of the species' status and revised the recovery plan in 2014 and determined that no status change was needed at that time. Most of the background information on PS biology and status presented throughout this biological opinion is taken directly from information presented in the recently revised recovery plan (Service 2014a) and three other biological opinions (Service 2009, Service 2010, and Service 2014b).

3.1. Species Description

The PS is a benthic, riverine fish that occupies the Mississippi River Basin, including the Mississippi River, Missouri River, and their major tributaries (i.e. Platte, Yellowstone, and Atchafalaya rivers) (Service 1990).

Recent studies have documented extensive hybridization between PS and SS in the Lower Mississippi River (Coastal Plain Management Unit) (Heist et al. in litt. 2016; Kuhajda et al. in litt. 2016; Jordan et al., in prep., 2018). These studies also confirmed that small numbers of genetically pure PS continue to occupy the Lower Mississippi River; however, genetic analysis is required for their accurate identification. There is currently no official Service policy for the protection of hybrids under the ESA, and the protection of hybrid progeny of endangered or threatened species is evaluated as necessary. For example, the protection of hybrids to facilitate law enforcement is recognized as appropriate under the ESA in cases where they are sympatric with pure species and morphologically difficult to distinguish (§4(3)). The duration and significance of hybridization between PS and SS is currently unknown, and it is not possible to visually distinguish pure PS from introgressed PS; therefore, for the purposes of management and consultation, we are considering all phenotypic PS as protected under the ESA.

The PS can grow to lengths of over 6 feet (ft) (1.8 meters [m]) and weights in excess of 80 pounds (lbs) (36 kilograms [kg]) in the upper Missouri River portion of its range. In the Mississippi River, specimens seldom exceed 3 ft (1 m) in length, or 20 lbs (9 kg) in weight. PS have a flattened, shovel-shaped snout, a long, slender, and completely armored caudal peduncle, and lack a spiracle (Smith 1979). As with other sturgeon, the mouth is toothless, protrusible, and ventrally positioned under the snout. The skeletal structure is primarily cartilaginous (Gilbraith et al. 1988). PS are similar in appearance to the more common and darker SS, and may be visually distinguished by the proportional lengths of inner and outer barbels, mouth width, proportion of head width to head length, proportion of head length to body length, and other characters. As noted above, morphological PS require genetic analysis to determine hybridization.

3.2. Life History

Habitat

PS habitats can generally be described as large, free-flowing, warm water, turbid river habitats with a diverse assemblage of physical attributes that are in a constant state of change (USFWS 1993, 2014a). Floodplains, backwaters, chutes, sloughs, islands, sandbars and main channel waters form the large river ecosystem that provide the macrohabitat requirements for all life stages of PS. Throughout its range, PS tend to select main channel habitats (Bramblett 1996, Sheehan et al., 1998, Service 2014a, Schramm et al. 2017); in the Lower Mississippi River (LMR), they have been found in a variety of main channel habitats, including natural and engineered habitats (Herrala et al, 2014).

PS are thought to occupy the sandy main channel in the Mississippi, Missouri, and Yellowstone rivers most commonly, but also are collected over gravel substrates (Service 2014a; Bramblett & White 200l; Hurley et al. 2004; Garvey et al. 2009; Koch et al. 2012). Several studies have documented PS near islands and dikes, and these habitats are thought to provide a break in water velocity and an increased area of depositional substrates for foraging (Garvey et al. 2009; Koch et al. 2012). Increased use of side channel and main channel islands has been noted in spring, and it is hypothesized that these habitats may be used as refugia during periods of increased flow (Garvey et al. 2009; Koch et al. 2012; Herrala et al, 2014). Recent telemetry monitoring of adult PS in the LMR indicates use of most channel habitats, including dikes, revetment, islands, secondary channels, etc. (Kroboth et al. 2013, Herrala et al, 2014). Islands and secondary channels are important in recruitment of larval sturgeon in the LMR (Hartfield et al., 2013).

PS occur within a variety of flow regimes (Garvey et al. 2009). In their upper range, adult PS are collected in depths that vary between 1.97-47.57 ft with bottom water velocities ranging from 2.20 ft/s and 2.62 ft/s (Service 2014; Bramblett & White 2001; Gerrity 2005). PS in the LMR have been collected at depths greater than 65 ft with a mean value of 32.81 ft, and water velocities greater than 5.91 ft/s with a mean value of 2.30 ft/s (ERDC unpublished data, Herrala et al., 2014). Turbidity is thought to be an important factor in habitat selection by PS, which have a tendency to occupy more turbid habitats than SS (Blevins 2011). In the LMR, PS have been collected in turbidities up to 340 NTU's with a mean value of 90 NTU's (ERDC unpublished data).

Much of the natural habitat throughout the range of PS has been altered by humans, and this is thought to have had a negative impact on this species (Service 2014). Habitats were once very diverse, and provided a variety of substrates and flow conditions (Baker et al. 1991; Service 1993). Extensive modification of the Missouri and Mississippi rivers over the last 100 years has drastically changed the form and function of the river (Baker et al. 1991; Prato 2003). Today, habitats are reduced and fragmented and much of the Mississippi River basin has been channelized to aid in navigation and flood control (Baker et al. 1991). The extent of impacts from range-wide habitat alteration on the PS is unknown, but recent studies have shown that in the unimpounded reaches (i.e., LMR), suitable habitat is available and supports a diverse aquatic community (Service 2007).

Movement

Like other sturgeon, PS is a migratory fish species that move upstream annually to spawn (Koch et al. 2012). Movements are thought to be triggered by increased water temperature and flow in spring months (Garvey et al. 2009; Blevins 2011). PS may remain sedentary, or remain in one area for much of the year, and then move either upstream or downstream during spring (Garvey et al. 2009, Herrala et al. 2017). It is possible that because movement in large, swift rivers requires a great amount of energy, this relatively inactive period may be a means to conserve energy (Garvey et al. 2009). Most active periods of movement in the upper Missouri River were between March 20 and June 20 (Bramblett & White 2001). In one study, individual fish traveled an average of 3.73 mi/day and one individual traveled over 9.94 mi/day (Garvey et al. 2009). PS in the Missouri River have been reported as traveling up to 5.90 mi/hour and 13.30 mi/day during active periods (Bramblett & White 2001). Based on a surrogate study that documented recaptures of SS in the Missouri River originally tagged in the LMR, PS may similarly undertake long-distance, multi- year upstream movements. Upstream distances approaching 1,245 mi have been recorded (ERDC unpublished data) and similar distances have been recorded for downstream movements (FWS unpublished data).

Aggregations of PS have been reported in several locations in the middle Mississippi River, particularly around gravel bars, including one annual aggregation at the Chain of Rocks Dam, thought to be related to spawning activities (Garvey et al. 2009). Aggregations of PS in the lower 8.70 mi of the Yellowstone River are also believed related to spawning activities of sturgeon from the Missouri River (Bramblett & White 2001). PS have been found to have active movement patterns during both the day and night, but they move mostly during the day (Bramblett & White 2001). There have been no verified spawning areas located in the LMR.

Feeding

Sturgeon are benthic feeders and are well adapted morphologically (ventral positioning of the mouth, laterally compressed body) for the benthic lifestyle (Service 1993; Findels 1997). Adult PS are primarily piscivorous (but still consume invertebrates), and are thought to switch to piscivory around age 5 or 6 (Kallemeyn 1983; Carlson et al. 1985; Hoover et al. 2007; Grohs et al. 2009). In a study of PS in the middle and lower Mississippi River, fish were a common dietary component and were represented primarily by Cyprinidae, Sciaenidae, and Clupeidae (Hoover et al. 2007). Other important dietary items for PS in the Mississippi River were larval Hydropsychidae (lnsecta: Trichoptera), Ephemeridae (lnsecta: Ephemeroptera), and Chironomidae (lnsecta: Diptera) (Hoover et al. 2007). PS diet varies depending on season and location, and these differences probably are related to prey availability (Hoover et al. 2007). In a Mississippi River dietary study, Trichoptera and Ephemeroptera were consumed in greater quantities in winter months in the lower Mississippi River, while the opposite trend was observed in the middle Mississippi River (Hoover et al. 2007). Hoover et al. (2007) also found that in both the middle Mississippi River and the lower Mississippi River, dietary richness is greatest in winter months.

3.3. Numbers, Reproduction, and Distribution

Spawning

Freshwater sturgeon travel upstream to spawn between the spring equinox and summer solstice, and it is possible that either a second or an extended spawning period may occur in the fall in southern portions of the range (i.e., Mississippi River) (Service 2007; Wildhaber et al. 2007; Schramm et al. 2017). These spawning migrations are thought to be triggered by several cues, including water temperature, water velocity, photoperiod, presence of a mate, and prey availability (Keenlyne 1997; DeLonay et al. 2007; DeLonay et al. 2009; Blevins 2011). Gamete development is completed during the upstream migration and sturgeon are thought to spawn near the apex of their migration (Bemis & Kynard 1997). Data suggests that female *Scaphirhynchus* spp. do not reach sexual maturity until ages 6-17 and spawn every 2-3 years, and that males do not reach sexual maturity until ages 4-9 (Keenlyne & Jenkins 1993; Colombo et al. 2007; Stahl 2008; Divers et al. 2009). PS and SS at lower latitudes (e.g., lower Mississippi River) may begin spawning at an earlier age than those in upper portions of the range (e.g., Upper and Middle Mississippi and Missouri Rivers) because they are thought to have shorter lifespans and smaller sizes (George et al. 2012). Also, LMR PS may be more highly fecund than those in northern portions of their range (George et al.2012). It is thought that PS, like SS spawn over gravel substrates, but spawning has never been observed in this species (Service 1993; DeLonay et al. 2007; DeLonay et al. 2009).

Rearing

PS hatch when they reach a total length (TL) of approximately ¼-inch. Larvae feed on yolk reserves and drift downstream for 11-17 days, until yolk reserves are depleted (Snyder 2002; Braaten et al. 2008; DeLonay et al. 2009). Length of drift and rate of yolk depletion are dependent on several factors, including water temperature, photoperiod, and water velocity (Snyder 2002; DeLonay et al. 2009). Larval drift is not completely understood and the impacts of artificial structures, as well as the role of eddies, are unknown (Kynard er al. 2007; Braaten et al. 2008). During drift, sturgeon repeat a "swim up and drift" pattern, in which they swim up in the water column from the bottom (<10 in) and then drift downstream (Kynard et al. 2002; Kynard et al. 2007). A hatchery series of SS from the Natchitoches National Fish Hatchery (NNFH) in Louisiana (J. Dean, unpublished data) reports complete yolk sac absorption at days 8-9 post-hatch, which is several days sooner than SS from Gavins Point National Fish Hatchery in South Dakota, so there could be a latitudinal difference in yolk absorption and larval maturation rates throughout the range of PS (Snyder 2002). The timing of exogenous feeding, which begins when yolk reserves are depleted and drifting has ceased, can differ latitudinally (DeLonay et al. 2009). The switch from endogenous to exogenous feeding is known as the “critical period", because mortality is likely if sturgeon do not find adequate food (Kynard et al. 2002; DeLonay et al. 2009). PS begin exogenous feeding around 11-12 days post- hatch in upper portions of their range, but exogenous feeding was observed in fish as small as 17.82mm TL in the lower Mississippi River (Harrison et al., unpublished data), which could be as young as 6-8 days (based on unpublished age and growth data from NNFH) post-hatch (Braaten et al. 2007). The diets of young of year and juvenile PS and SS in upper portions of their ranges are much like those of the adult SS, and are primarily composed of aquatic insects and other benthic macroinvertebrates (Braaten et al. 2007; Wanner et al. 2007; Grohs et al. 2009). Young of year and juvenile PS in the LMR feed primarily on Chironomidae over sand in channel habitats (Harrison et al. 2012, unpublished data). Juvenile PS are thought to switch to piscivory around ages 5-6 (Kallemeyn 1983; Carlson et al. 1985; Hoover et al. 2007; Grohs et al. 2009).

Kynard et al. (2002) found larval PS to be photopositive and showed little preference to substrate color, except for a slight preference for light substrates when exogenous feeding began. It is thought that PS become increasingly photonegative starting around day 11 post-hatching (Kynard et al. 2002). In this same study, larval sturgeon swam in open habitats, seeking no cover under rocks in the swimming tube, and aggregated in small groups around days 3-5 post-hatching (Kynard et al. 2002). The black tail phenotype of these young sturgeon is thought to aid in recognition and aggregation (Kynard et al. 2002). PS have been observed swimming and drifting at a wide range (2-118 in) above the bottom depending on water velocities (although most fish are thought to stay in the lower 20 in of the water column), and drift velocities are thought to range from 0.98-2.29 ft/s (Kynard et al. 2002; Kynard et al. 2007; Braaten et al. 2008). Drift distance of larval sturgeon is thought to be between 85.75-329.33 mi (Kynard et al. 2007; Braaten et al. 2008). Juvenile PS have been found in water depths ranging from an average of 7.58-8.14 ft in the upper Missouri River (Gerrity 2005). Maximum critical swimming speeds for juvenile PS range from 0.32 ft/s to 0.82 ft/s, depending on size, with larger juveniles (6-8 in TL) able to withstand higher water velocities than their smaller counterparts (5-6 in TL) (Adams et al. 1999). In the Lower Mississippi River, larval sturgeon collections are associated with flooded sand bars in secondary channels and sand/gravel reefs in the main channel (Hartfield et al. 2013, Schramm et al 2017)

Distribution and Abundance

PS occur in parts of the Mississippi River Basin, including the Mississippi River below the confluence of the Missouri River and its distributary, the Atchafalaya River, as well as in the Missouri River and its tributaries, the Yellowstone and Platte Rivers (Kallemeyn 1983; Killgore et al. 2007a). Recovery efforts have divided the extensive range of PS into four management units (Service 2013b) based on population variation (i.e., morphological, genetic) and habitat differences (i.e., physiographic regions, impounded, unimpounded reaches) throughout the extensive range of the PS (Service 2013b). Those units are:

> *Great Plains Management Unit (GPMU)*: The GPMU extends from Great Falls of the Missouri River, Montana, to Fort Randall Dam, South Dakota, and includes the Yellowstone, Marias, Milk rivers.
>
> *Central Lowlands Management Unit (CLMU)*: The CLMU includes the Missouri River from Fort Randall Dam, South Dakota, to the confluence of the Grand River, Missouri, and includes the lower Platte and lower Kansas Rivers.
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> *Interior Highlands Management Unit (IHMU)*: The IHMU includes the Missouri River from the confluence of the Grand River, Missouri, to the confluence of the Mississippi River, Missouri, and the Mississippi River from Keokuk, Iowa, to the confluence of the Ohio River, Illinois.
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> *Coastal Plain Management Unit (CPMU)*: The CPMU includes the LMR from the confluence of the Ohio River, Illinois, to the Gulf of Mexico, Louisiana (the action area of this consultation), and the Atchafalaya River distributary system, Louisiana.

To date, more than 1,100 PS have been captured in the CPMU since listing (approximately 500 PS from the LMR, and 600 from the Atchafalaya River) (Killgore et al. 2007a, Service database 2018), exceeding capture numbers from all other management units, combined. Pallid to shovelnose ratios range between 1:6 to l:30 in the LMR, depending upon river reach, and 1:6 in the Atchafalaya River (Killgore et al. 2007a; Service 2007). The ratio of PS to SS in the lower Mississippi River reach where the BCS is located is typically 1:3 (ERDC 2013). Age-0 PS have been captured in both the LMR and the Atchafalaya, although it is unclear exactly where and when spawning occurs (ERDC, unpublished data; Hartfield et al. 2013). Age-0 and immature PS are difficult to distinguish from SS (Hartfield et al. 2013); however, capture data indicates annual recruitment of immature PS since 1991 (Service database 2013). The occurrence of *Scaphirhynchus* was extended from River Mile 85 downstream 50 miles to River Mile 33, when ERDC collected two young-of-year *Scaphirhynchus* sturgeon with a trawl in the lower Mississippi River in November of 2016 (USACE BA 2017).

3.4. Conservation Needs and Threats

Much of the following information is taken from Service documents (2000, 2007, and 2014). The PS was listed due to the apparent lack of recruitment for over 15 years, and the habitat threats existing at the time of listing. Destruction and alteration of habitats by human modification of the river system is believed to be the primary cause of declines in reproduction, growth, and survival of the PS. The historic range of PS as described by Bailey and Cross (1954) encompassed the middle and lower Mississippi River, the Missouri River, and the lower reaches of the Platte, Kansas, and Yellowstone Rivers. Bailey and Cross (1954) noted a PS was captured at Keokuk, IA, at the Iowa and Missouri state border. Duffy et al. (1996) stated that the historic range of PS once included the Mississippi River upstream to Keokuk , IA, before that reach of the river was converted into a series of locks and dams for commercial navigation (Coker 1930).

Habitat destruction/modification and the curtailment of range were primarily attributed to the construction and operation of dams on the upper Missouri River and modification of riverine habitat by channelization of the lower main stem Missouri and Mississippi Rivers. Dams substantially fragmented PS range in the upper Missouri River. However, free-flowing riverine conditions currently exist throughout the lower 2,000 mi (3,218 km) (60%) of the PS's historical range. Although the lower Missouri River continues to be impacted by regulated flows and modified habitats, actions have been developed and are being implemented to address habitat issues. Recent studies and data from the Mississippi River suggests that riverine habitats are less degraded than previously believed , and that they continue to support diverse and productive aquatic communities, including PS. Although there are ongoing programs to protect and improve habitat conditions in the four management units, positive effects from these programs on PS have not been quantified.

Carlson and Pflieger (1981) stated that PS are rare but widely distributed in both the Missouri River and in the Mississippi River downstream from the mouth of the Missouri River. A comparison of PS and SS catch records provides an indication of the rarity of PS. At the time of their original description, PS composed 1 in 500 river sturgeon captured in the Mississippi River at Grafton, Illinois (Forbes and Richardson 1905). PS were more abundant in the lower Missouri River near West Alton, MO, representing one-fifth of the river sturgeon captured (Forbes and Richardson 1905). Carlson et al. (1985) captured 4,355 river sturgeon in 12 sampling stations on the Missouri and Mississippi Rivers. Field identification revealed 11 (0.25 percent) PS. Grady et al. (in preparation) collected 4,435 river sturgeon in the lower 850 mi (1,367 km) of the Missouri River and 100 mi (161 km) of the middle Mississippi River from November 1997 to April 2000. Field identification revealed nine wild (0.20 percent) and nine hatchery-origin PS.

Today, PS, although variable in abundance, are ubiquitous throughout most of the free-flowing Mississippi River. When the PS was listed as endangered they were only occasionally found in the following areas from the Missouri River: 1) between the Marias River and Fort Peck Reservoir in Montana ; 2) between Fort Peck Dam and Lake Sakakawea (near Williston, North Dakota); 3) within the lower 70 mi (113 km) of the Yellowstone River downstream of Fallon, Montana ; 4) in the headwaters of Lake Sharpe in South Dakota; 5) near the mouth of the Platte River near Plattsmouth, Nebraska ; and, 6) below river mile 218 to the mouth in the State of Missouri.

Keenlyne (1989) updated previously published and unpublished information on distribution and abundance of PS. He reported pre-1980 catch records for the Mississippi River from its mouth upstream to its confluence with the Missouri River, a length of 1,153 mi (1,857 km); in the lower 35 mi (56 km) of the Yazoo/Big Sunflower and St. Francis Rivers (tributaries to the Mississippi); in the Missouri River from its mouth to Fort Benton, Montana , a length of 2,063 mi (3,323 km); and, in the lower 39 mi (64 km) of the Kansas River, the lower 21 mi (34 km) of the Platte River, and the lower 200 mi (322 km) of the Yellowstone River (tributaries to the Missouri River). The total range is approximately 3,500 mi (5,635 km) of river.

Currently, the Missouri River (1,154 mi [1,857 km]) has been modified significantly with approximately 36 percent of the riverine habitat inundated by reservoirs, 40 percent channelized, and the remaining 24 percent altered due to dam operations (Service 1993). Most of the major tributaries of the Missouri and Mississippi Rivers have also been altered to various degrees by dams, water depletions, channelization, and riparian corridor modifications.

The middle Mississippi River, from the mouth of the Missouri River to the mouth of the Ohio River, is principally channelized with few remaining secondary channels, sand bars, islands and abandoned channels. The middle Mississippi River has been extensively diked; navigation channels and flood control levees have reduced the size of the floodplain by 39 percent.

Levee construction along the LMR, from the Ohio River to the Gulf, has eliminated major natural floodways and reduced the land area of the floodplain by more than 90 percent (Fremling et al. 1989). Fremling et al. (1989) also report that levee construction isolated many floodplain lakes and raised river banks. As a result of levee construction, 15 meander loops were severed between 1933 and 1942.

Destruction and alteration of big-river ecologic functions and habitats once provided by the Missouri and Mississippi Rivers were believed to be the primary cause of declines in reproduction, growth, and survival of PS (Service 2014). The physical and chemical elements of channel morphology, flow regime, water temperature, sediment transport, turbidity, and nutrient inputs once functioned within the big-river ecosystem to provide habitat for PS and other native species. On the main stem of the Missouri River today, approximately 36 percent of riverine habitat within the PS's range has been transformed from river to lake by construction of six massive earthen dams by the USACE between 1926 and 1952 (Service 1993). Another 40 percent of the river downstream of the dams has been channelized. The remaining 24 percent of river habitat has been altered by changes in water temperature and flow caused by dam operations.

The channelized reach of the Missouri River downstream of Ponca, Nebraska, once a diverse assemblage of braided channels, sandbars, and backwaters, is now confined within a narrow channel of rather uniform width and swift current. Morris et al. (1968) found that channelization of the Missouri River reduced the surface area by approximately 67 percent. Funk and Robinson (1974) calculated that, following channelization, the length of the Missouri River between Rulo, Nebraska, and its mouth (~500 river miles [310 km]) had been reduced by 8 percent, and the water surface area had been reduced by 50 percent.

Missouri River aquatic habitat between and downstream of main stem dams has been altered by reductions in sediment and organic matter transport/deposition, flow modification, hypolimnetic releases, and narrowing of the river through channel degradation. Those activities have adversely impacted the natural river dynamics by reducing the diversity of bottom contours and substrates, slowing accumulation of organic matter, reducing overbank flooding, changing seasonal patterns, severing flows to backwater areas, and reducing turbidity and water temperature (Hesse 1987). The Missouri River dams also are believed to have adversely affected PS by blocking migration routes and fragmenting habitats (Service 2014).

The pattern of flow velocity, volume, and timing of the pre-development rivers provided the essential life requirements of native large-river fishes like the PS and paddlefish. Hesse and Mestl (1993) found a significant relationship between the density of paddlefish larvae and two indices (timing and volume) of discharge from Fort Randall Dam. They concluded that when dam operations caused discharge to fluctuate widely during spring spawning, the density of drifting larvae was lower, and when annual runoff volume was highest, paddlefish larval density was highest. Hesse and Mestl (1987) also modeled these same two indices of discharge from Fort Randall Dam with an index of year-class strength. They demonstrated significant negative relationships between artificial flow fluctuations in the spring and poor year-class development for several native and introduced fish species including river carpsucker, shorthead redhorse, channel catfish, flathead catfish, sauger, smallmouth buffalo, and bigmouth buffalo. The sample size of sturgeon was too small to model in that study; however, a clear relationship existed between poor year-class development in most native species studied and the artificial hydrograph.

Modde and Schmulbach (1973) found that during periods of low dam releases, the secondary subsidiary channels, which normally feed into the river channel, become exposed to the atmosphere and thus cease to contribute littoral benthic organisms into the drift. Schmulbach (1974) states that use of sandbar habitats were second only to cattail marsh habitats as nursery ground for immature fishes of many species.

Even though extensive flood control, water supply, and navigation projects constrict and control the Missouri and Mississippi Rivers with reservoirs, stabilized banks, jetties, dikes, levees, and revetments, relatively unaltered remnant reaches of the Missouri River and the Mississippi River from the Missouri River confluence to the Gulf of Mexico still provide habitat useable by PS. However, anthropogenic alterations (i.e., levee construction) effectively increased river stage and velocities at higher discharges by preventing overbank flows on the adjacent floodplains (Baker et al. 1991).

The upper ends of the reservoirs in the upper basin may be influencing the recruitment of larval sturgeon. Both the shovelnose and PS larvae have a propensity to drift after hatching (Kynard et al. 1998a, b). Bramblett (1996) found that the PS may be spawning in the Yellowstone River between river mile 9 and river mile 20 upriver, and that from historic catch records, there is some evidence to indicate that the occurrence of PS catches coincide with the spring spawning at the mouth of the Tongue River (Service 2000). SS have been found to spawn in the tributaries of the Yellowstone River as well as in the Marias, Teton, Powder and Tongue Rivers (Service 2000). SS are successfully recruiting and reproducing in the river stretches in the upper basin and this may be directly related to the amount of larval and juvenile habitat they have available downstream of the spawning sites.

Early indications in culturing PS indicate that sturgeon larvae will not survive in a silty substrate. In 1998, most of the larval sturgeon held in tanks at Gavins Point NFH, experienced high mortality when the water supply contained a large amount of silt which settled on the bottom of the tanks. Migration routes to spawning sites on the lower Yellowstone River have been fragmented by low-head dams used for water supply intakes. Such habitat fragmentation has forced PS to spawn closer to reservoir habitats and reduced the distance larval sturgeon can drift after hatching.

Historically, PS, SS, and lake sturgeon were commercially harvested in all States on the Missouri and Mississippi Rivers (Helms 1974). The larger lake and PS were sought for their eggs which were sold as caviar, whereas SS were historically destroyed as bycatch. Commercial harvest of all sturgeon has declined substantially since record-keeping began in the late 1800s. Most commercial catch records for sturgeon have not differentiated between species and combined harvests as high as 430,889 lb (195,450 kg) were recorded in the Mississippi River in the early 1890s, but had declined to less than 20,061 lb (9,100 kg) by 1950 (Carlander 1954). Lower harvests reflected a decline in SS abundance since the early 1900s (Pflieger 1975). Today, commercial harvest of SS is still allowed in 5 of the 13 states where PS occur.

Mortality of PS occurs as a result of illegal and incidental harvest from both sport and commercial fishing activities (Service 2000). Sturgeon species, in general, are highly vulnerable to impacts from fishing mortality due to unusual combinations of morphology, habits, and life history characteristics (Boreman 1997). In 1990, the head of a PS was found at a sport-fish cleaning station in South Dakota, and in 1992 a PS was found dead in a commercial fisherman's hoop net in Louisiana. In 1997, four PS were found in an Illinois fish market (Sheehan et al. 1997). It is probable that PS are affected by the illegal take of eggs for the caviar market. In 1999, a PS that was part of a movement and habitat study on the lower Platte River was harvested by a recreational angler (Service 2000). Bettoli et al. (2008) found 1.8 percent of the total sturgeon catch in Tennessee caviar harvest were composed of PS. In addition, such illegal and incidental harvest may skew PS sex ratios such that hybridization with shovelnose is exacerbated. Killgore et al. (2007) indicated that higher mortality rates for PS in the middle Mississippi River may be a result of habitat limitation and incidental take by the commercial shovelnose fishery.

Currently, only a sport and/or aboriginal fishery exist for lake sturgeon, due to such low population levels (Todd 1998). SS are commercially harvested in eight states and a sport fishing season exists in a number of states (Mosher 1998). Although information on the commercial harvest of SS is limited, Illinois reported the commercial harvest of SS was 43,406 lbs (19,689 kg) of flesh and 233 lbs (106 kg) of eggs in 1997 and Missouri reported a 52-year mean annual harvest of 8,157 lbs (3,700 kg) of flesh (Todd 1998) and an unknown quantity of eggs for 1998. Missouri also has a sport fishery for SS but has limited data on the quantities harvested (Mosher 1998).

The previous lack of genetic information on the PS and SS led to a hybridization debate. In recent years, however, several studies have increased our knowledge of the genetic, morphological, and habitat differences of those two species. Campton et al. (1995) collected data that support the hypothesis that PS and SS are reproductively isolated in less altered habitats, such as the upper Missouri River. Campton et al. (2000) suggested that natural hybridization, backcrossing, and genetic introgression between PS and SS may be reducing the genetic divergence between those species. Sheehan has identified 86 separate loci for microsatellite analysis that are being used to differentiate between pallid, shovelnose and suspected hybrid sturgeon (Service 2000).

Bramblett (1996) found substantial differences in habitat use and movements between adult PS and SS in less altered habitats. Presumably, the loss of habitat diversity caused by human-induced environmental changes inhibits naturally occurring reproductive isolating mechanisms. Campton et al. (1995) and Sheehan et al. (1997) note that hybridization suggests that similar areas are currently being used by both species for spawning.

Carlson et al. (1985) studied morphological characteristics of 4,332 sturgeon from the Missouri and middle Mississippi Rivers. Of that group, they identified 11 PS and 12 PS/SS hybrids. Suspected hybrids have recently been observed in commercial fish catches on the lower Missouri and the middle and lower Mississippi Rivers (Service 2000). Bailey and Cross (1954) did not report hybrids, which may indicate that hybridization is a recent phenomenon resulting from environmental changes caused by human-induced reductions in habitat diversity and measurable changes in environmental variables such as turbidity, flow regimes, and substrate types (Carlson et al. 1985). A study by Keenlyne et al. (1994) concluded that hybridization may be occurring in half the river reaches within the range of PS and that hybrids may represent a high proportion of remaining sturgeon stocks. Hartfield and Kuhajda (2009) stated that hybridization rates in the Mississippi River have been overestimated, and there is no direct evidence linking the morphological or genetic variation defined as hybridization between PS and SS in the lower Missouri, Mississippi, or Atchafalaya Rivers with recent anthropogenic activities. Hybridization could present a threat to the survival of PS through genetic swamping if the hybrids are fertile, and through competition for limited habitat (Carlson et al. 1985). Keenlyne et al. (1994) noted few hybrids showing intermediacy in all characteristics as would be expected in a first generation cross, indicating the hybrids are fertile and reproducing.

Hubbs (1955) indicated that the frequency of natural hybridization in fish was a function of the environment, and the seriousness of the consequences of hybridization depends on hybrid viability. Hybridization can occur in fish if spawning habitat is limited, if many individuals of one potential parent species lives in proximity to a limited number of the other parent species, if spawning habitat is modified and rendered intermediate, if spawning seasons overlap, or where movement to reach suitable spawning habitat is limited (Hubbs 1955). Any of those conditions, or a combination of them, could be causing the apparent breakdown of isolating mechanisms that prevented hybridization between these species in the past (Keenlyne et al. 1994). Hartfield and Kuhajada (2009) examined three of the five original specimens used to describe the PS and found that the character indices currently used to distinguish the fish identify some of the type specimens as hybrids. In conclusion, they stated they found no evidence directly linking habitat modification and hybridization particularly in the Mississippi River and no evidence that hybridization constitutes an anthropogenic threat to the PS.

More recent studies have documented extensive hybridization between PS and SS in the LMR (Coastal Plain Management Unit) (Heist et al. in litt. 2016; Kuhajda et al. in litt. 2016; Jordan et al., in prep., 2018). These studies also confirmed that small numbers of genetically pure PS continue to occupy the LMR; however, genetic analysis is required for their accurate identification. There is currently no official Service policy for the protection of hybrids under the ESA, and the protection of hybrid progeny of endangered or threatened species is evaluated as necessary. For example, the protection of hybrids to facilitate law enforcement is recognized as appropriate under the ESA in cases where they are sympatric with pure species and morphologically difficult to distinguish (§4(3)). The duration and significance of hybridization between pallid and shovelnose sturgeon is currently unknown, and it is not possible to visually distinguish pure PS from introgressed PS; therefore, for the purposes of management and consultation, we are considering all phenotypic PS as protected under the ESA.

Although more information is needed, pollution is also likely an exacerbating threat to the species over much of its range. Pollution of the Missouri River by organic wastes from towns, packing houses, and stockyards was evident by the early 1900s and continued to increase as populations grew and additional industries were established along the river. Due to the presence of a variety of pollutants, numerous fish harvest and consumption advisories have been issued over the last decade or two from Kansas City, MO, to the mouth of the Mississippi River. That distance represents about 45 percent of the PS's total range. Currently there are no advisories listed by the U.S. Environmental Protection Agency (EPA) south of Tennessee (approximately 710 miles).

Polychlorinated biphenyls (PCBs), cadmium, mercury, and selenium have been detected at elevated, but far below lethal, concentrations in tissue of three PS collected from the Missouri River in North Dakota and Nebraska. Detectable concentrations of chlordane, dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), and dieldrin also were found (Ruelle and Keenlyne 1994). The prolonged egg maturation cycle of PS, combined with bioaccumulation of certain contaminants in eggs, could make contaminants a likely agent adversely affecting eggs and embryo, and development or survival of fry, thereby reducing reproductive success.

In examining the similarities and differences between SS and PS, Ruelle and Keenlyne (1994) concluded that, while the SS may not meet all the traits desired for a surrogate, it may be the best available for contaminant studies. Conzelmann et al. (1997) reported that trace element concentrations in Old River Control Complex (ORCC) SS were generally higher than in SS from other areas. Certain trace elements can adversely affect reproduction and development, and may ultimately be lethal if concentrations are excessive. Most trace element levels were unremarkable; however, cadmium, copper, lead, and selenium concentrations were elevated in ORCC samples and may warrant concern (Conzelmann et al. 1997).

Conzelmann et al. (1997) also reported that organochlorine (OC) pesticide concentrations are the main environmental concern in Louisiana's SS, and consequently, in the PS. Shovelnose OC concentrations were generally greater than OC concentrations observed in fishes from other areas, and ORCC SS toxaphene levels were elevated compared to the National Contaminants Biomonitoring Program. Toxaphene possesses known carcinogenic, teratogenic, xenotoxic, and mutagenic properties; can cause suppression of the immune system; and may function as an endocrine system imitator, blocker, or disrupter (Colburn and Clements 1992). Those factors make toxaphene the greatest OC concern in ORCC SS and, by extension, the ORCC PS (Conzelmann et al. 1997). Further investigations are needed to identify contaminant sources in the Mississippi and Atchafalaya Rivers and to assess the role, if any, of contaminants in the decline of PS populations.

Another issue that is negatively impacting PS throughout its range is entrainment. The loss of PS associated with water intake structures has not been accurately quantified. The EPA published final regulations on Cooling Water Intake Structures for Existing Facilities per requirements of §316(b) of the Clean Water Act. The rule making was divided into three phases. However, only Phases I and II appear applicable to inland facilities; Phase III applies to coastal and offshore cooling intake structures associated with coastal and offshore oil and gas extraction facilities. The following rule summaries are based on information found at the website https://www.epa.gov/cooling-water-intakes. Phase I rules, completed in 2001, require permit holders to develop and implement techniques that will minimize impingement mortality and entrainment. Phase II, completed in 2004, covers existing power generation facilities that are designed to withdraw 50 million gallons per day or more with 25 percent of that water used for cooling purposes only. Phase II and the existing facility portion of Phase III were remanded to EPA for reconsideration and a final rule combined the remands into one rule in 2014. This rule, implemented through National Pollutant Discharge Elimination System permits, is intended to minimize negative effects associated with water cooling structures.

Section 316(b) of the Clean Water Act requires the EPA to insure that aquatic organisms are protected from impingement or entrainment. As part of the Phase II ruling, some power plants have begun conducting required entrainment studies. Preliminary data on the Missouri River suggests that entrainment may be a serious threat that warrants more investigation. Initial results from work conducted by Mid-America at their Neal Smith power facilities found hatchery-reared PS were being entrained (Jordan in litt. 2006, Ledwin in litt. 2006, Williams in litt. 2006). Over a 5-month period, four known hatchery-reared PS had been entrained, of which two were released alive and two were found dead. Ongoing entrainment studies required by the Clean Water Act will provide more data on the effects of entrainment. However, addressing entrainment issues may not occur immediately and continued take of hatchery- reared or wild PS will limit the effectiveness of recovery efforts. In addition to cooling intake structures for power facilities, concerns have been raised regarding entrainment associated with dredge operations and irrigation diversions. Currently little data are available regarding the effects of dredge operations. However, the USACE St. Louis District, and the Dredging Operations and Environmental Research Program have initiated work to assess dredge entrainment of fish species and the potential effects that those operations may have on larval and juvenile *Scaphirhynchus*. Data for escape speed, station-holding ability, rheotaxis and response to noise, and dredge flow fields are being used to develop a risk assessment model for entrainment of sturgeon by dredges. Entrainment has been documented in the irrigation canal supplied by the Intake Dam on the Yellowstone River (Jaeger et al. 2004). Given that entrainment has been documented to occur in the few instances it has been studied, further evaluation of entrainment at other water withdrawal points is warranted across the PS's range to adequately evaluate this threat. Entrainment of PS stocked in the Mississippi River into the Atchafalaya River via the ORCC has also been documented by the capture of a tagged stocked sturgeon that was released into the Mississippi River.

Biological Opinions which allow the take of a PS also represent a factor that should be considered when examining factors that could have an influence on the PS population. Table 2 presents all completed Biological Opinions for the LMR.

Table 2. Completed Biological Opinions for the Lower Mississippi River.

Opinions (year)	Species	Authorized Take	Take Reported	Critical Habitat
2003	Biological Opinion on Natchitoches National Fish Hatchery's Collection of Endangered Pallid Sturgeon from Louisiana Waters for Propagation and Research	90 adults/season for 5 season (harassment) 8 adults/season for 5 seasons (death)	23 harassment (2003)	NA
2004	Modification to revise 2003 IT estimates for BO (4-7-3-702) on Natchitoches National Fish Hatchery's Activities	120 adults/season for 5 (harassment) 14 adults/season for (death) potential	329 (Atchafalaya) harassment (through 2010) 7 dead (2004)	NA
2004	Programmatic Biological Opinion Addressing Effects of the Southeast region's Section 10(a)(1)(A) Permitting on the Pallid Sturgeon (5-years)	28 adults in captive propagation/year (death) 2,500 to 15,000 captive year-class 90 days old or older (one-time loss-death) 200 larval/juvenile/year sampling (death) 3, 5-inch or greater fish/year netting (death o injury) 3 fish/year external tagging (death or injury) 1 fish/year transport (death) 5 fish/year radio-tracking (death or injury)	461 (LMR) harassment (through 2012) 1 dead (2006) 2 dead (2007) 1 dead (2009)	NA

Opinions (year)	Species	Authorized Take	Take Reported	Critical Habitat
2005	Mod 2-adding new forms of take to the 2004 revised IT (4-7-04-734) for the 2003 (4-7-03-702) on Natchitoches National Fish Hatchery's Activities	14 wild pallid sturgeon/season (death) 15,000 hatchery-reared pallid sturgeon/season (death)	NA	NA
2009	Biological Opinion on 2008 Emergency Opening of Bonnet Carré Spillway, USACE	14 adults (harassment) 92 adults (death)	14 adult harassment Unknown deaths	NA
2010	Biological Opinion on Medium White Ditch Diversion	23 adults/year (death) potential	0	NA
2010	Biological Opinion on Small diversion at Convent/Blind River	7 adults/year (death) potential	0	NA
2010	Taxonomic ID study	100 adults (death)	76	NA
2013	Mod-Programmatic BO	21 adults/year(death) potential	0	NA
2013	USACE CIP	Unspecified	0	NA
2014	USACE Permits for Sand and Gravel Mining in the Lower Mississippi River	Unspecified	NA	NA
Total[1]		120 adults/yr (harassment) 192 adults (death) 14-28/year (potential death) 200 larval fish/year (potential death) 2,500-15,000 year-class 90 days old or older (one-time loss-death)	827 adult harassment 87 adult known dead Unknown <200/year larvae collected	NA

[1] The original estimates for the 2003 BO are not included as they were revised in 2004,
[2] Hatchery propagation was terminated in Region 4 in 2005.

4. ENVIRONMENTAL BASELINE

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the PS, its habitat, and ecosystem within the action area. The environmental baseline is a "snapshot" of the species' health in the action area at the time of the consultation and does not include the effects of the actions under review.

4.1. Action Area Numbers, Reproduction, and Distribution

The actions under consultation occurred within the LMR area of the Coastal Plains Management Area. The status of the PS within the action area is discussed within the STATUS OF THE SPECIES/CRITICAL HABITAT section above.

4.2. Action Area Conservation Needs and Threats

The conservation needs and threats of the species within the action area would be among those previously discussed under STATUS OF THE SPECIES/CRITICAL HABITAT, but would include only those pertaining to the southern-portion (i.e., the LMR) of the species' range as previously described.

5. EFFECTS OF THE ACTION

This section analyzes the direct and indirect effects of the actions on the PS, which includes the direct and indirect effects of interrelated and interdependent actions. Direct effects are caused by the actions and occur at the same time and place. Indirect effects are caused by the actions, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the actions in section 2 of this BO.

5.1. Effects of 2011 Operation on the Pallid Sturgeon

The USACE operated the BCS for 43 days (May 9, 2011 to June 20, 2011). Prior to the operation of the BCS, the ERDC Fish Ecology Team was tasked by the USACE with conducting pre-operation sampling efforts in the vicinity of the BCS. Since the life expectancy of entrained sturgeon is unknown, it is possible that any unrecovered sturgeon entrained during a previously analyzed emergency operation would still be alive within the spillway. It was assumed that as leakage through the structure began, the highly rheotactic behavior of sturgeon would cause previously entrained sturgeon within the BCS to migrate towards the structure. The ERDC team sampled several reaches associated with the BCS on May 4 and 5, 2011, prior to the opening of the BCS. No sturgeon were observed or captured during this sampling. Immediately following the 2011 BCS closure, the ERDC, the Louisiana Department of Wildlife and Fisheries (LDWF), the USACE, and Nicholls State University (NSU) sampled for approximately four weeks and recovered 99 *Scaphirhynchus* (20 pallid, 78 shovelnose, and one intermediate) sturgeon captured within the outfall of the BCS. Two of the recovered PS were recaptures of entrained sturgeon recovered from the previous BCS emergency operation in 2008. All sturgeon captured were returned to the Mississippi River. The majority of the sturgeon captured following the 2011 BCS closure were collected over the first week and a half.

5.2. Effects of 2016 Operation on Pallid Sturgeon

The USACE operated the BCS for 22 days (January 10, 2016 to February 1, 2016). Immediately following the BCS closure, the ERDC sampled for approximately 3 weeks and recovered no sturgeon within the outfall of the BCS. On March 2, 2016, Dr. Dave Schultz of Nicholl's State University (NSU) captured one SS during a sampling effort separate from the ERDC's recovery efforts.

5.3. Summary of the Effects of the Actions

Because the 2011 and 2016 openings were similar actions, the effects of the actions on sturgeon are expected to be similar. Therefore, in order to produce an efficient and effective consultation, the following section discusses the mutual effects to PS for both openings. Any differences that may occur between the openings are indicated as needed for clarification.

PS were known to occur within this reach of the river prior to the BCS operations. Depths utilized by PS have been reported throughout its range; however, because of the varying total depth of the rivers throughout its range this information may have limited applicability to the LMR unless depth is expressed as a percent of the total river depth. Water depths in the Mississippi River at low water in front of the structure range from -2 to -119 feet North American Vertical Datum (NAVD); average minimum depth is -8.6 feet NAVD and average maximum depth is -86 NAVD feet (USACE 2004). The calculated percent of total river depth utilized by PS is approximately 70ft (Bramblett 1996 cited in Constant et al., 1997, Constant et al., 1997). Using that percentage compared to water depths during the diversion would indicate that PS should not be found on the batture in front of the structure during its operation. However, the usage of this habitat (incidental usage or actively used) has never been quantified or documented in literature. Incomplete knowledge of PS life history, especially in the LMR does not preclude high water usage of the batture as feeding habitat or velocity refugia.

The Pallid Sturgeon Lower Basin Recovery Workgroup (Workgroup) has identified information gaps essential to the consultation and recovery processes in the Lower Mississippi River Basin. These include the following: relative abundance of PS, demographics, feeding habits, habitat use, hybridization ratios, presence of fish diseases in the wild, population anomalies, and reliable separation and identification of PS, SS, and hybrids. A more recent information gap identified by the Workgroup is the entrainment of adult and juvenile PS through the ORCC and potential entrainment through the existing coastal wetland restoration diversions. The implications of the BCS operations on sturgeon populations within the LMR can be better understood due to the completion of the “Entrainment Studies of Pallid Sturgeon Associated with Water Diversions in the Lower Mississippi River” (ERDC 2013), although some data gaps remain. The ERDC is currently conducting sturgeon entrainment studies at the ORCC and has documented entrainment of sonic tagged PS and SS. Therefore, the sturgeons' response to encountering the BCS flows (e.g., avoidance versus actively sought) is unknown. There are several hypotheses on possible sturgeon reactions to entrainment that must be considered to determine levels of take potential, as follows: (1) only sturgeon located near the structure during its opening were entrained (i.e., no increase in sturgeon entrainment because of active avoidance); (2) sturgeon actively swam into the structure seeking velocity refuge from main-channel flows, and/or seeking food sources on the batture, and/or in a perceived secondary channel (i.e., the BCS); or, (3) sturgeon were entrained passively or actively during down-river migration. It is likely that the reaction to the BCS opening would vary with life stage of the sturgeon, and actual "take" may be due to a combination of any of the above hypotheses.

There are no known topographic or hydrographic features (apart from river current) that would appear to attract the sturgeon to the vicinity of the BCS. ERDC (2013) postulated various methods to establish the number of sturgeon "taken" and tried to incorporate most probable factors involved in their analysis of potential entrainment of sturgeon. Factors considered in some of their methods included the loss of sturgeon into Lake Pontchartrain through the BCS during the diversion, and/or through emigration once flows were reduced during the BCS closure, and the volume and/or duration of the diversion.

The volume of water diverted through the BCS is primarily related to the river stage (a measurement of water volume in the river) at the structure and the number of bays that are opened. The 350 bays that comprise the structure are 20-feet-wide and have two sill elevations of 16.8 feet National Geodetic Vertical Datum 1927 (NGVD) and 14.8 feet NGVD (a 2-foot difference). For the May 9 – June 20, 2011, opening, the maximum number of bays opened during this diversion was 330. This 43-day period diverted the greatest amount of water during the opening with a maximum of 315,930 cfs, twice the maximum discharge rate created by the 2008 operation (160,144 cfs). The increased magnitude of discharge through the BCS could have been one contributing factor of displacing sturgeon to a larger extent, although the abbreviated period of flow in the canals may have contributed to sturgeon catch patterns. PS, as well as SS, are strongly rheotactic and will orient into the direction of water flow. Within a week of the BCS closing, the velocity in the canals below the structure dropped essentially to zero and the water levels dropped quickly throughout the spillway. Because of this, entrained sturgeon were less likely to move towards the base of the structure, unlike their behavior after the 2008 closure. The rapid drop in water levels hampered physical movement through and over road crossings that bisect the spillway. This caused sturgeon to become stranded in the stilling basin below the BCS structure or in the spillway lakes that become disconnected to the canals; thus, more entrained PS were recovered during the 2011 operation (20) than the 2008 operation (14), likely due to higher discharge rates and a longer operation period. For the 2016 BCS opening, the maximum number of bays opened was 210 which lasted from January 10, 2016, to February 1, 2016. The 22-day period diverted a maximum of 202,500 cfs. As with the 2011 opening, within a week of the BCS closing, the water levels dropped quickly throughout the spillway.

Effects of the actions on larval, fry, and juvenile fish

No larval *Scaphirhynchus* were collected by the LDWF or ERDC after either closure of the Spillway; however, the collection of larval sturgeon within any habitat typically requires considerable efforts which often only results in the capture of a few specimens (Quist 2004). The methods to collect larval and young-of-year (YOY) *Scaphirhynchus* have been refined during the past decade; therefore, the numbers of larval *Scarphirhynchus* collected within the Mississippi River have increased (Herzog et al. 2005, Hrabik et al. 2007, and Phelps et al. 2010). In 1985, a shovelnose larva was collected at White Castle (approximately 65 miles upstream of the BCS; River Mile 193) (Constant et al. 1997). Larval SS have also been collected in the vicinity of Vicksburg, Mississippi (River Mile 435) approximately 307 miles upstream of the BCS (Constant et al., 1997, Hartfield et al. 2013, Schramm et al. 2017). Kynard et al. (2002) and Braaten et al. (2008) reported longer larval drift times resulting in greater distances traveled by PS larvae when compared to shovelnose larvae. PS larvae were determined to travel at approximately the mean river velocity for the first 11 days after hatching and then slightly slower for the next 6 days because of the sturgeon's transition to a benthic life stage. Distances covered during larval drift are affected by water velocity; however, water temperature can affect larval /fry development rates (warmer temperatures increase development rates) which would also affect drift distances.

Higher water velocities are experienced with larger flood events (USACE 2009). Water velocities in the Mississippi River south of Baton Rouge (River Mile 231) have been documented to range from 4.4 feet per second (fps) to 1.5 fps depending on the discharge. South of Baton Rouge the river channel is larger and the slope of the river decreases, thus velocities are slower than those above Baton Rouge (Wells 1980). Surface water velocities measured north of

Baton Rouge range from 2.9fps to 5.6 fps for discharges of 200,000 cfs to l million cfs, respectively. Three surface velocity cross-sections taken south of Baton Rouge at discharges of 350,000 cfs, 460,000 cfs, and 470,000 cfs never had velocities greater than 4 fps, but a surface velocity cross-section taken north of Baton Rouge measured velocities in excess of 5 fps for a discharge of 310,000 cfs (Wells 1980). The USACE has computed surface water velocities of the Mississippi River at New Orleans (River Mile 107; approximately 20 miles downstream). For the river stages when the BCS was operated in 2011, river velocities ranged from about 8.5 fps to slightly less than 10.3 fps. Velocities calculated for 60 percent of the river's depth ranged from 6.2 fps to under 7.3 fps. The opening and closing of the BCS occurred as the discharge below the ORCC reached 1.5 million cfs. The most southern PS spawning sites are unknown; however, potential gravel bar spawning sites occur at various locations between Baton Rouge, Louisiana, and Vicksburg, Mississippi (River Mile 435), approximately 307 miles upstream of the structure. If a mean water velocity of 5.9 fps (i.e., 4 miles per hour) is assumed to have occurred from Vicksburg to the BCS, larvae could travel as much as 96 miles per day, barring entrainment into the eddies, the batture, and other areas.

One 7-day and one 9-day post-hatch larval sturgeon were collected near Vicksburg, Mississippi, on May 20, which indicated that hatching occurred on the 13 and 11 of May. The previously mentioned larval sturgeon captured at White Castle was collected on May 15. Other larval sturgeon recently captured between Greenville and Vicksburg, Mississippi (approximate rivers miles 540 and 440, respectively), would indicate hatching occurred in early to mid-May (Schramm et al. 2017).

Due to the 2016 opening occurring during the winter months, the presence of larval sturgeon would not be expected; thus, resulting in no effects to larval sturgeon.

Effects of the actions on sub-adult and adult

Hoover et al. (2005) examined swimming performance of juvenile PS (maximum size 6.3 inches) at different velocities. Minimum escape speeds for PS ranged from 1.6 to 1.7 fps and burst speeds were determined to range from 1.7 to 2.95 fps; however, because they frequently failed to exhibit rheotaxis, their ability to avoid entrainment based on swimming performance was determined to be relatively low. Overall, approximately 18 percent were not positively rheotatic; however, Adams et al (1999) found only 7 percent were non-rheotatic. White and Mefford (2002) examined swimming behavior and performance of SS ranging from 25.2 to 31.5 inches in length. Their ability to navigate the length of the test flume was best (60 to 90 percent) over a smooth bottom followed by coarse sand, gravel, and then cobble, but the small sample size and large variability precluded this from being a definitive conclusion. The greatest success at negotiating the flume was determined to occur between the range of 2 and 4 fps; however success at greater velocities (e.g., 6 fps) did occur. Approximately 30 percent failed to exhibit rheotactic behavior at velocities below 1.6 fps. Conversely, Adams et al. (1997) found all adult shovelnose to be positively rheotactic. PS are believed to avoid areas that have very little or no water velocity (DeLonay and Little 2002, cited in Quist 2004, Erickson 1992 cited in Service, no date) and leave areas that no longer have flows (Backes et al., 1992, Constant et al. 1997).

The timing of PS movements and migration in the LMR may differ from that of other rivers and other portions of the Mississippi River (Constant et al., 1997). Migrations and movement in the Atchafalaya River was associated with water temperatures between 14 and 21 Celsius (C) (Constant et al,. 1997) and spring and early summer seasons (Schramm and Dunn 2008). The USACE's Biological Assessment stated that the mean water temperature of the Mississippi River during the 2011 opening was 29.5ºC, higher than the above range while the mean water temperature of the Mississippi River during the 2016 opening was 10.8ºC. The absence of sturgeon recovered after the 2016 opening suggests that season and water temperature may influence the risk of entrainment through the BCS. At this time of year, it is possible that sturgeon are sedentary to conserve energy before migrating further upriver during the spring (Garvey et al. 2009).

After the 2008 opening, sampling and visual patrolling within the BCS was conducted at the end of the 2009 high water event resulting in the collection of five additional sturgeon. Four dead SS were found floating in the stilling basin next to the structure between June 19 and June 24, 2009. A fifth sturgeon was found desiccated on the bank of Barbars Canal on June 22, 2009, but was too decomposed to identify. It is not known if these additional sturgeon survived within the BCS since the previous opening, were entrained during the annual single-bay test opening or through leakage during the 2009 high water event, or a combination of all of the above. The Service electroshocked several ponds within the BCS in June 2005 (previous opening was in 1997) and in June 2008 (following the 2008 BCS closure), and no sturgeon were collected either year. BCS personnel observed the de-watering of several clay borrow pits within the BCS following the 2008 opening and 2009 high water event. Hundreds of fish comprising many species were observed, but no sturgeon species were seen. On a monthly basis, LDWF took two 16-foot trawls and one 100-foot-seine samples near the shoreline of the BCS prior to, during, and after the 1973 opening but no sturgeon were collected (LWFC 1976). Because of the uncertainty of the origin of the above mentioned sturgeons (2008 opening or 2009 high water event) the Service elected to not utilize them in any analysis.

Because of the size of PS captured, in the BCS in 2011 (18 to 36 inches), it is believed that the presence of the vertical wall would preclude any of them from returning to the river. The velocities within the BCS and the topography would provide sufficient areas where sturgeon could seek velocity refuge and remain in the BCS even until its closure. Downstream migrating sturgeon could swim into the lake, lose orientation to any flow fields, and not return to the BCS. Information on PS preference for flows indicates that this number would be relatively small, but not discountable.

With assistance from the ERDC, the Service utilized a hydrology-based method to determine the number of sturgeon entrained during the 2008 opening of the BCS. The hydrology method is based upon a proposed relationship between the volume of water diverted and the number of sturgeon entrained. The hydrology methodology is similar to those recommended to determine entrainment by power plants (Goodyear 1977). However, methods proposed by Goodyear could not be used because of insufficient information for some model parameters. While the method below is similar to that used to determine take for the 2008 BCS opening, changes were made based on more recent information and data obtained from the operating of the Davis Pond Freshwater Diversion. In the take determination for the BCS 2008 opening, the ratio of PS to SS in the river was utilized in the calculations. However, for this determination the ratio was taken from sturgeon captured in the operating diversion. While the ratios are fairly close (1:2 for the river and 1:4 for the diversion), the differences could possibly be explained by habitat usage and behavioral differences when sturgeon encounter areas of higher velocities. Use of PS to SS ratios to determine take was also previously utilized in the Final Biological Opinion for the Upper Mississippi River – Illinois Waterway System Navigation Feasibility Study (2004). The methodology currently utilized represents the Service's best efforts to determine entrainment; however, the Service recognizes that as more information about PS life history, behavior, and abundance becomes available, these methods may need to be revised or totally replaced.

The Service based the effects of the actions on sub-adult/adult PS on the following assumptions:

1) All fish entrained will not return to the river.
2) Adult PS and SS will be entrained at the same approximate ratio that occured in the Davis Pond Outfall Canal study.
3) With increases in the duration and volume of water diverted, additional fish will be entrained (i.e., the level of entrainment considered is directly proportional to the duration or volume of diverted water).
4) All tagged fish in the vicinity of sampling efforts will have equal probability of being captured.
5) The percentage of tagged sturgeon captured of all tagged sturgeon available for capture in the Davis Pond Outfall Canal represents the effectiveness of sampling efforts (i.e., percent success) in determining the total number of sturgeon entrained.

The Service recognizes that the assumptions made may not be totally accurate for all sturgeon entrained but believes that this represents a scenario that is most likely to be the response of the majority of sturgeon that could be entrained and, therefore, represents utilization of the best available information.

The Service calculated the maximum take of sub-adult/adult PS in the following manner:

1) From July 2009 to June 2010, there were 20 tagged sturgeon located in the Davis Pond Outfall Canal in the vicinity of sampling efforts being conducted by NSU on days that they sampled. During this time, two tagged sturgeon were captured (i.e., 10 percent successful recapture rate) and four untagged sturgeon were captured, with one being a PS (i.e., 25 percent).
2) The 10 percent successful recapture rate when applied to the four untagged sturgeon captured would estimate the number of entrained sturgeon to be 40, of which 25 percent are PS (i.e., 10 fish).
3) The total discharge through the Davis Pond structure during the sampling period ($9.472\text{x } 10^{10}$ cubic ft) was divided by the estimated number of PS (i.e., 10) to determine the amount of volume discharged per each entrained fish ($9.472\text{x } 10^{9}$ cubic ft).
4) The proposed maximum discharge for each day was summed to determine the total volume of water diverted during the structure's operation (i.e., $8.9401 \text{ x } 10^{6}$

cfs for 2011 and 2.8 x 10^{11} cfs for 2016). This total volume was divided by the volume of water discharged per each entrained fish (9.472 x 10^9 cubic ft) to calculate the possible maximum number of fish entrained.

The take calculation for the 2011 BCS Operation:

8.9401 x 10^6 cfs *(24*60*60) = 7.7242 x 10^{11} cfs
7.7242 x 10^{11} cfs/ 9.472 x 10^9 cfs = 81.55 fish for this operation (rounded to 82)

The take calculation for the 2016 BCS Operation:

2.8 x 10^6 cfs*(24*60*60) = 2.4412 x 10^{11} cfs
2.4412 x 10^{11} cfs/9.472 x 10^9 cfs = 25.77 fish for this operation (rounded to 26)

The Service calculated take for the 2016 BCS Operation to be 26 sub-adult/adult PS entrained during the opening; however, mean water temperatures were approximately 20ºC lower during the 2016 operation compared to the 2011 operation (e.g. 10.8ºC in 2016, 29.5ºC in 2011) and no sturgeon (pallid or shovelnose) were captured after the 2016 BCS closure compared to the 20 PS captured after the 2011 BCS closure.

5.4. Figures for Effects of the Action

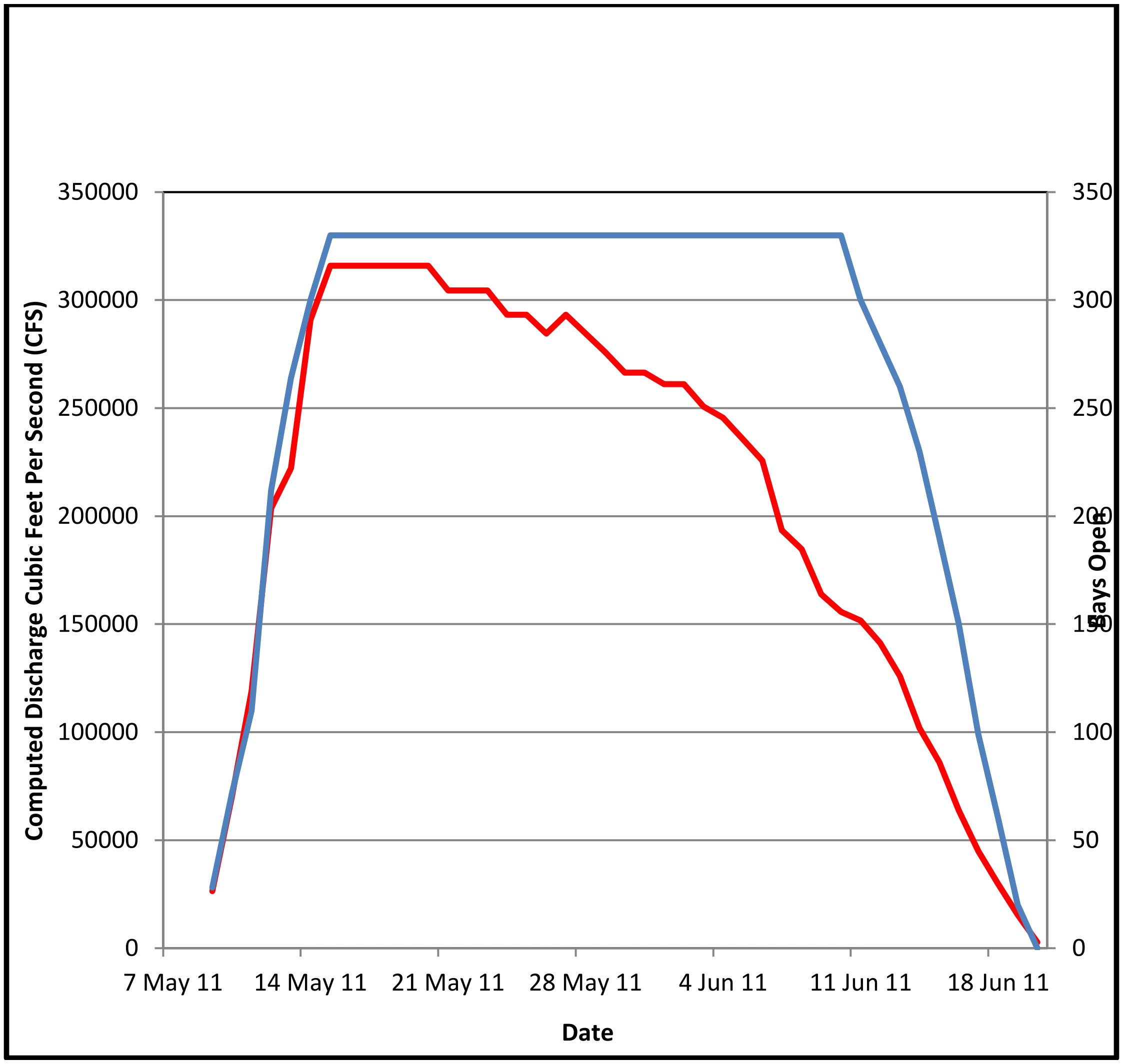

Figure 3. Number of Open Bays and Computed Discharge through the BCS 2011 opening (USACE 2017)

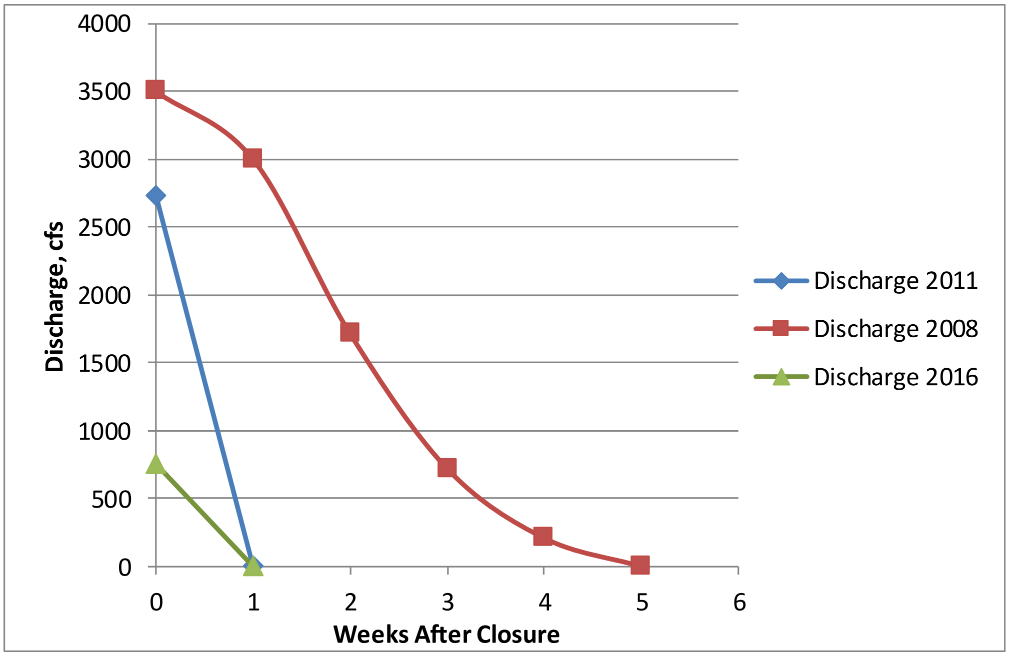

Figure 4. Discharge (cfs) measure in Barbar's Canal after the 2008, 2011, and 2016 openings (USACE 2017).

6. CUMULATIVE EFFECTS

For purposes of consultation under ESA §7, cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate consultation under §7 of the ESA.

We know that the Mid-Barataria Sediment Diversion Project is reasonably certain to be implemented downstream of the BCS. However, that project is a federal action that will require separate consultation under §7 of the ESA. We are not aware of any non-federal actions in the action area that may affect the PS. Therefore, cumulative effects are not relevant to formulating our opinion for the action.

7. CONCLUSION

In this section, we summarize and interpret the findings of the previous sections (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated critical habitat.

"*Jeopardize the continued existence*" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

After reviewing the current status of the PS, the effects of the BCS openings in 2011 and 2016, and the cumulative effects; it is the Service's biological opinion that operation of the BCS flood control feature in 2011 and 2016 is not likely to have jeopardized the continued existence of the species. No critical habitat has been designated for the PS; therefore, none will be affected.

8. INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) and regulations issued under §4(d) prohibit the take of endangered and threatened fish and wildlife species without special exemption. The term "take" in the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA §3). In regulations at 50 CFR §17.3, the Service further defines:

- "harass" as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering;"
- "harm" as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering;" and
- "incidental take" as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited, provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS).

An emergency response action that may affect listed species and designated critical habitat is the sole circumstance under which Federal agencies may initiate ESA consultation *after* implementing the action. However, the Services have no authority to exempt the taking of listed species from the ESA take prohibitions after-the-fact. Therefore, the ITS of an emergency consultation BO does not include reasonable and prudent measures or terms and conditions to minimize take, unless the agency has an ongoing action related to the emergency. The Action evaluated in this BO is concluded.

The actions considered in this BO include a conservation measure to recover entrained PS from the BCS and return them to the LMR. Through this statement, the Service authorizes this conservation measure as an exception to the prohibitions against trapping, capturing, or collecting listed species.

8.1. Amount or Extent of Take

This section specifies the amount or extent of take of PS that the actions are reasonably certain to cause, which we estimated in the "Effects of the Action" section of this BO. We reference, but do not repeat, these analyses here. The Service believes incidental take in the form of mortality and harassment resulted from the two emergency operations of the BCS. Our assessment of take did not anticipate the death of any adult PS captured and released back into the Mississippi River but did include mortality associated with entrapment behind the BCS structure.

2011 BCS Operation

The Service acknowledges that incidental take in the form of harassment of 20 PS resulted from the entrainment, recovery, and release of those individuals back into the Mississippi River. While handling of fish can induce stress that may lead to mortality the Service does not believe that the recovery and return to the Mississippi River of those 20 PS resulted in any of their deaths.

The Service estimated incidental loss (by death or serious injury) of 82 PS adults.

The Service anticipated the incidental take (direct death) of an unknown number of larval/juvenile PS due to entrainment but that number cannot be quantified. However, because the BCS was being closed at the onset of spawning season, the Service believes that the number of larval/juvenile sturgeon taken was very minimal.

2016 BCS Operation

There were no PS captured after the closure of the structure; therefore, no incidental take in the form of harassment of PS resulted from the entrainment, recovery, and release of those individuals back into the Mississippi River.

The Service estimated incidental loss (by death or serious injury) of 26 PS adults.

Due to this operation opening during the winter, the Service does not anticipate that any incidental take (direct death) of larval/juvenile PS occurred due to entrainment.

9. CONSERVATION RECOMMENDATIONS

§7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species.

Following the 2008 flood event, the USACE and the Mississippi Valley Division (MVD) initiated studies to comply with Conservation Recommendations from the 2009 BO. These studies have:

- Documented and quantified sturgeon entrainment in existing diversions compared to adjacent river reaches;
- Estimated population size of PS in river reaches associated with diversions; and,
- Developed population viability models of PS to analyze impacts of entrainment-based "take" by water diversions (ERDC-EL, 2013).

Additional studies are currently in progress to determine sturgeon entrainment rates at the ORCC, including seasons and conditions in which entrainment occurs, as well as studies on the role of the batture to the LMR ecosystem. The MVD has also developed and implemented a Conservation Plan for listed species in the LMR which promotes conservation of PS through their engineering and construction activities (Killgore et al., 2014). The Service encourages the USACE to continue these studies and conservation measures.

10. REINITIATION NOTICE

Formal consultation for the actions considered in this BO is concluded. Reinitiating consultation is required if the USACE retains discretionary involvement or control over the actions (or is authorized by law) when:

a. the amount or extent of incidental take is exceeded;
b. new information reveals that the actions may have affected listed species or designated critical habitat in a manner or to an extent not considered in this BO;
c. the actions were modified in a manner that caused effects to listed species or designated critical habitat not considered in this BO; or
d. a new species is listed or critical habitat designated that the actions may affect.

In instances where the amount or extent of incidental take is exceeded, the USACE is required to immediately request a reinitiation of formal consultation.

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